

DOCUMENT RESUME

ED 259 003

TM 850 372

AUTHOR Monk, John S.; And Others
TITLE Examination of Achievement Differences Due to Cognitive Tendency, Sex, and IQ Using an Intensive Time-Series Design.
PUB DATE Mar 85
NOTE 20p.; Paper presented at the Annual Meeting of the American Educational Research Association (69th, Chicago, IL, March 31-April 4, 1985).
PUB TYPE Speeches/Conference Papers (150) -- Reports - Research/Technical (143)
EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Academic Achievement; Aptitude Treatment Interaction; Cognitive Processes; Cognitive Style; Intelligence Differences; Junior High Schools; *Measurement Techniques; Performance Factors; *Research Design; Sex Differences; Statistical Analysis
IDENTIFIERS *Time Series Design

ABSTRACT

This study was conducted to determine how the pattern of learning on an abstract concept, plate tectonics, differed between groups of different cognitive levels, sex, and intelligence quotient (IQ). The intensive time-series design was used to examine the achievement of eighth grade and ninth grade earth science students. The unique characteristic of this study was the use of the intensive time-series design to reveal differences in patterns of learning between groups. Results indicated that no definite trend was present as learning occurred among the concrete cognitive tendency students, while a strong positive trend existed as learning occurred in the formal cognitive tendency group. Achievement was greater for students with higher IQs than for those with lower IQs. No clear achievement differences were observed between the sexes. The study indicated the power of the intensive time-series design which permitted researchers to investigate learning as a dynamic process. (DWH)

* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *

ED259003

BEST COPY AVAILABLE

EXAMINATION OF ACHIEVEMENT DIFFERENCES DUE
TO COGNITIVE TENDENCY, SEX, AND IQ USING AN
INTENSIVE TIME-SERIES DESIGN

JOHN S. MONK
VICTOR J. MAYER
The Ohio State University
PETER PEZARO
Kibbutze Yireel, Isreal

The Ohio State University
059 Ramseyer Hall
29 West Woodruff
Columbus, Ohio 43210

"PERMISSION TO REPRODUCE THIS
MATERIAL HAS BEEN GRANTED BY

Mayer, Victor J.

TO THE EDUCATIONAL RESOURCES
INFORMATION CENTER (ERIC)."

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION
CENTER (ERIC)

☒ This document has been reproduced as
received from the person or organization
originating it.
☐ Minor changes have been made to improve
reproduction quality.

* Points of view or opinions stated in this docu-
ment do not necessarily represent official NIE
position or policy.

TM 850372

INTRODUCTION

The intensive time-series design has been shown to be a valid method for monitoring group performance on a variety of criteria. (Farnsworth and Mayer, 1984; Mayer and Rojas, 1983; Mayer and Kozlow, 1980, Mayer and Lewis, 1979) The design has also been shown to yield discriminating information about group achievement (Farnsworth and Mayer, 1984). In this study the intensive time-series design is used to examine the achievement of groups of eighth-grade and ninth-grade earth-science students on an abstract concept, plate tectonics. Grouping was conducted on the basis of cognitive tendency, sex, and IQ. The study sought information on the following question: How does the pattern of learning on abstract concept such as plate tectonics differ between groups of different cognitive levels, sex, and IQ.

POPULATION

Data were collected from students of two earth science teachers. Teacher 1, with 103 ninth-grade students, and Teacher 2, with 133 eighth-grade students from different schools located in middle to upper socio-economic suburban communities near Columbus, Ohio.

Students of Teacher 1 were grouped by sex and cognitive tendency. Students of Teacher 2 were grouped by sex, cognitive tendency, and IQ. Grouping by cognitive tendency for both teachers was done on the basis of student rankings on the Test of Logical Thinking (TOLT) (Tobin and Capie, 1981). Three groups of approximately equivalent size were formed, a Formal cognitive tendency group, a Concrete cognitive tendency group, and a third, middle group whose data were not used in the study. IQ groups were formed on the basis of student IQ rank. Three groups of approximately equal size were formed with the High and Low IQ groups being used in the study.

DESIGN

A multiple-group single-intervention time-series design (Glass, Willson, Gottman, 1975) was used to collect daily data on achievement using a unit on plate tectonics as the intervention. Single multiple-choice items drawn from a pool of 75 plate tectonics items were randomly assigned to student in each of the three cognitive tendency groups, such that the same set of items chosen on a given day were used for each of the three cognitive tendency groups. No student received the same item more than once during the study.

Two multiple-item instruments were constructed from the pool of 75 plate tectonics achievement items. These forms each contained 32 unique but parallel items and 11 common items. These instruments were administered on the first day of the Followup stage of the study to all students, the two forms randomly assigned to students within each teacher's classes. Form A reliability (Cronbach's alpha) was found to be 0.87; Form B reliability was 0.88.

No significant differences were found between student performance between forms A and B on the eleven common items.

The implementation of the intensive time-series design yielded slightly different temporal sequencing for Teacher 1 and Teacher 2. This sequencing is presented below in Campbell and Stanley (1963) notation.

T1:	0 ₁	0 ₂	...	0 ₁₀	I0 ₁₁	I0 ₁₂	...	I0 ₃₆	0 ₃₇	0 ₃₈	...	0 ₅₀
T2:	0 ₁	0 ₂	...	0 ₁₇	I0 ₁₈	I0 ₁₉	...	I0 ₄₂	0 ₄₃	0 ₄₄	...	0 ₅₄
	-----				-----				-----			
	BASELINE				INTERVENTION				FOLLOWUP			

Where: 0 represents a single item administered to each group member
I indicates the occurrence of intervention

Group member scores were pooled to form daily group scores using Rasch procedures. (Rasch, 1960; Wright, 1977, Monk, in press).

ANALYSIS

Any time-series data may display autocorrelation of error terms. For this reason the first analyses conducted were autoregression procedures as outlined by Willson (1982). In all cases, autocorrelation was determined to be a non-significant factor.

Visual inspection of graphed data was next used to identify possible differences in either the slope or level of the daily group achievement data. Linear regressions were then run for each group for the Baseline, Intervention, and Followup stages of the study. Differences between groups at each stage and differences within each group between stages were examined using analysis of variance (ANOVA) procedures.

RESULTS

Cognitive Tendency Grouping

Visual examination of the data indicated that differences in achievement did exist between group achievement for the Formal and Concrete cognitive tendency groups. The most obvious differences were that the

Formal Group generally did better than the Concrete Group. The Formal Group also displayed a positive trend in achievement during the Intervention period of the study not evident for the Concrete group data. (See Figures 1 and 2)

Insert Figures 1 and 2 here

Linear regressions confirmed the presence of positive slopes in the daily data for the Formal groups of each teacher during Intervention. (Tables 1 and 2). Statistically significant negative slopes were found for the Baseline stage for the Concrete group of Teacher 2, for the Baseline stage for the Formal group of Teacher 1, and for the Followup stage for the Formal group of Teacher 2. ANOVAs performed to compare groups for each teacher at each stage of the study indicated the Formal students significantly outperformed the Concrete students. The magnitude of the differences observed and the level of significance for those differences generally increased for each stage of the study. (See Table 3 and Table 4)

Insert Tables 1, 2, 3 and 4 about here

Examining the data for within group differences for the Formal cognitive tendency group shows a progression of significant differences from the Baseline through the Followup stages of the study: the Baseline group-mean-score is less than the Intervention group-mean-score which in turn is less than the Followup group-mean-score. For both Concrete groups the Baseline group-mean-score is significantly less than the Followup group mean score. The Baseline and Followup group-mean-scores do not differ significantly from the Intervention group-mean-score. (Tables 5 and 6)

Insert Tables 5 and 6 about here

Sex Groups

Visual examination of the graphed data for sex groups for Teachers 1 and 2 did not reveal consistent differences in level or trend. (See Figures 3 and 4)

Insert Figure 3 and 4 about here

Linear regression indicates there are significant positive slopes for the daily data of the Male group of Teacher 1 and the Female group of Teacher 2. (Table 7 and Table 8) ANOVA followup procedures indicate that the mean group scores for the Male group of Teacher 1 for the Intervention and Followup stages of the study are higher than those of the Female group. For Teacher 2, the Males outscored the Females only for the Baseline stage of the study. (Tables 9 and 10)

Insert Tables 7, 8, 9, and 10 about here

ANOVAs conducted to compare stage of study differences within sex groups indicate that for Teacher 1 the Baseline stage scores were significantly less than Followup scores for both Male and Female groups. No significant differences were found between Baseline or Followup scores and Intervention scores for either sex group of Teacher 1. For Teacher 2 both groups displayed significant increases in achievement scores for each stage of the study. (See Tables 11 and 12)

Insert Tables 11 and 12 about here

IQ Groups

Visual inspection of the data for the IQ groups of Teacher 2 indicates that the High IQ group outperformed the Low IQ group throughout the study. The High IQ group data also appears to display a significant positive trend during the Intervention stage of the study. (Figure 5) The positive trend in achievement for the High IQ group is confirmed by linear regression analysis. (Table 13). ANOVAs examining differences between group score means indicate that, for all stages of the study, the High IQ group outscored the low IQ group. These differences became larger as the study progressed. (Table 14)

Insert Figure 5 about here

Insert Tables 13 and 14 about here

ANOVAs examining the stage by stage differences for the IQ groups indicate the LOW IQ group only displays a significant difference between Baseline and Followup means, whereas there exists significant differences between all stages for the High IQ groups. (Table 15)

Insert Table 15 about here

DISCUSSION

The analysis of the intensive time-series data collected in this study indicates that students displaying a more formal cognitive tendency outperform those displaying a more concrete cognitive tendency when learning an abstract concept such as plate tectonics. This is as would be expected from the literature. (Kamii, 1979; Lawson and Lawson, 1979; and others) The unique characteristic of this study is the use of the intensive time-series design to reveal differences in patterns of learning between two groups, whereas the typical pre-post test design can only provide information on gross differences in achievement caused by intervention. This study reveals that no definite trend is present as learning occurs among the Concrete cognitive tendency children while there is a strong positive trend as learning occurs in the Formal cognitive tendency group.

Conclusions for the IQ groups are similar to those for the cognitive tendency groups. Achievement is greater for students with higher IQs than for students with lower IQs. This is, of course expected. Intensive time-series design again allows us to state that the differences observed are linked to a learning rate or trend.

For the sex groups, no clear differences were observed. Such findings parallel those of Butts (1981) and others who have examined research findings for male and female students.

The findings of this study not only raise questions about the learning processes which generate the differences observed between groups, but also highlight the power of the intensive time-series design which allows researchers to investigate learning as a dynamic process. Intriguing as the differences in patterns revealed in this study are, even more so are the day to day fluctuations in performance seen in the graphs of the daily group data. Research designs used in the past are incapable of revealing this phenomenon. The possible effects of such fluctuations on the interpretation of results of other studies using more traditional designs must be recognized. Even more important for cognitive psychologists, educational researchers, and teachers are the reasons for such daily changes in ability to perform. Are they the result of environmental factors, cognitive processes, social interactions, or some combination of these and/or other factors? The search for an answer to this question will be a rich area for future research.

TABLE 1

Summary of Linear Regressions of Achievement by Day for
Teacher 1: Cognitive Tendency Groups

Group	Stage	df	F	p	r ²	Slope
Concrete	Baseline	1/8	3.41	0.10	0.30	
	Intervention	1/24	3.89	0.06	0.14	
	Followup	1/12	1.32	0.27	0.10	
Formal	Baseline	1/8	9.25	0.02	0.54	-0.115
	Intervention	1/24	4.36	0.05	0.15	0.029
	Followup	1/12	0.01	0.91	0.00	

TABLE 2

Summary of Linear Regressions of Achievement by Day for
Teacher 2: Cognitive Tendency Groups

Group	Stage	df	F	p	r ²	Slope
Concrete	Baseline	1/15	7.80	0.01	0.34	-0.067
	Intervention	1/23	0.25	0.62	0.01	
	Followup	1/10	0.45	0.52	0.04	
Formal	Baseline	1/15	0.00	0.97	0.00	
	Intervention	1/23	17.11	0.0004	0.43	0.046
	Followup	1/10	4.95	0.05	0.32	-0.059

TABLE 3

Summary of Achievement ANOVAs for Teacher 1:
Comparing Cognitive Tendency Groups

Stage of Comparison	df	MS	F	p
Baseline	1	1.55	8.75	.008
Intervention	1	9.45	33.83	.0001
Followup	1	13.60	76.69	.0001
Relevant Means:				
	Concrete		Formal	
Baseline (n=10)	2.43		2.98	
Intervention (n=26)	2.65		3.50	
Followup (n=14)	2.79		4.19	

TABLE 4

Summary of Achievement ANOVAs for Teacher 2:
Comparing Cognitive Tendency Groups

Stage of Comparison	df	MS	F	p
Baseline	1	1.52	6.15	.019
Intervention	1	4.39	19.85	.0001
Followup	1	5.59	26.93	.0001
Relevant Means:				
	Concrete		Formal	
Baseline (n=17)	2.03		2.46	
Intervention (n=25)	2.43		3.03	
Followup (n=12)	2.77		3.74	

TABLE 5

Summary of Achievement ANOVAs for Teacher 1:
Comparing Stages for the Cognitive Tendency Groups

Group	df	MS	F	p
Concrete	2	0.39	2.46	0.096
Means	2.43	2.65	2.79	
	Baseline	Intervention	Followup	
Formal	2	4.44	14.63	0.0001
Scheffe' ^a	-----	-----	-----	-----
Means	2.98	3.50	4.19	
	Baseline	Intervention	Followup	

^aNote: The Scheffe' followup is expressed as a bar joining means which are not significantly different at the $p \leq 0.05$ level. In this instance there is no significant difference between Baseline and Intervention scores, however both Baseline and Intervention scores are significantly lower than Followup scores.

TABLE 6

Summary of Achievement ANOVAs for Teacher 2:
Comparing Stages for the Cognitive Tendency Groups

Group	df	MS	F	p
Concrete	2	1.99	8.06	0.0009
Scheffe'	-----	-----	-----	-----
Means	2.03	2.43	2.77	
	Baseline	Intervention	Followup	
Formal	2	5.01	28.31	0.0001
Scheffe'	-----	-----	-----	-----
Means	2.46	3.03	3.74	
	Baseline	Intervention	Followup	

TABLE 7

Summary of Linear Regressions of Achievement by Day for
Teacher 1: Gender Groups

Group	Stage	df	F	p	r ²	Slope
Female	Baseline	1/8	0.52	0.49	0.06	
	Intervention	1/24	1.31	0.26	0.52	
	Followup	1/12	0.05	0.82	0.01	
Male	Baseline	1/8	2.59	0.15	0.24	
	Intervention	1/24	18.40	0.0003	0.43	0.0457
	Followup	1/12	0.11	0.75	0.01	

TABLE 8

Summary of Linear Regressions of Achievement by Day for
Teacher 2: Gender Groups

Group	Stage	df	F	p	r ²	Slope
Female	Baseline	1/15	1.40	0.25	0.09	
	Intervention	1/23	11.48	0.0025	0.33	0.0360
	Followup	1/10	1.47	0.24	0.06	
Male	Baseline	1/15	3.86	0.07	0.20	
	Intervention	1/23	1.47	0.24	0.06	
	Followup	1/10	1.11	0.30	0.05	

TABLE 9

Summary of Achievement ANOVAs for Teacher 1:
Comparing Gender Groups

Stage of Comparison	df	MS	F	p
Baseline	1	0.12	1.85	0.19
Intervention	1	1.49	7.69	0.0078
Followup	1	2.27	14.11	0.0009
Relevant Means:				
	Female		Male	
Baseline (n=10)	2.53		2.68	
Intervention (n=26)	2.80		3.14	
Followup (n=14)	3.03		3.60	

TABLE 10

Summary of Achievement ANOVAs for Teacher 2:
Comparing Gender Groups

Stage of Comparison	df	MS	F	p
Baseline	1	0.62	7.74	0.009
Intervention	1	0.54	0.36	0.55
Followup	1	0.01	0.01	0.92
Relevant Means:				
	Female		Male	
Baseline (n=17)	2.13		2.40	
Intervention (n=25)	2.67		2.74	
Followup (n=12)	3.24		3.74	

TABLE 11

Summary of Achievement ANOVAs for Teacher 1:
Comparing Stages for the Gender Groups

Group	df	MS	F	p
Female	2	0.75	6.08	0.0045
Scheffe'	-----			
Means	2.53	2.80	3.03	
	Baseline	Intervention	Followup	
Male	2	2.49	12.60	0.0001
Scheffe'	-----			
Means	2.68	3.14	3.60	
	Baseline	Intervention	Followup	

TABLE 12

Summary of Achievement ANOVAs for Teacher 2:
Comparing Stages for the Gender Groups

Group	df	MS	F	p
Female	2	4.02	25.82	0.0001
Scheffe'	-----			
Means	2.13	2.67	3.24	
	Baseline	Intervention	Followup	
Male	2	2.43	29.89	0.0001
Scheffe	-----			
Means	2.40	2.74	3.24	
	Baseline	Intervention	Followup	

TABLE 13

Summary of Linear Regressions of Achievement by Day for
Teacher 2: IQ Groups

Group	Stage	df	F	p	r ²	Slope
Low IQ	Baseline	1/15	4.14	0.06	0.22	
	Intervention	1/23	0.30	0.59	0.15	
	Followup	1/10	2.54	0.15	0.20	
High IQ	Baseline	1/15	0.76	0.40	0.05	
	Intervention	1/23	16.92	0.0005	0.42	0.035
	Followup	1/10	0.01	0.93	0.00	

TABLE 14

Summary of Achievement ANOVAs for Teacher 2:
Comparing IQ Groups

Stage of Comparison	df	MS	F	p
Baseline	1	2.00	8.85	0.0055
Intervention	1	6.71	13.73	0.0001
Followup	1	12.31	97.18	0.0001
Relevant Means:	Low IQ	High IQ		
Baseline (n=17)	1.99	2.48		
Intervention (n=25)	2.31	3.05		
Followup (n=12)	2.54	3.97		

TABLE 15

Summary of Achievement ANOVAs for Teacher 2:
Comparing Stages for the IQ Groups

Group	df	MS	F	p
Low IQ	1	1.11	5.74	0.013
Scheffe'	-----			
Means	1.99	2.31	2.54	
	Baseline	Intervention	Followup	
High IQ	2	7.86	56.38	0.0001
Scheffe'	-----	-----	-----	-----
Means	2.48	3.05	3.97	
	Baseline	Intervention	Followup	

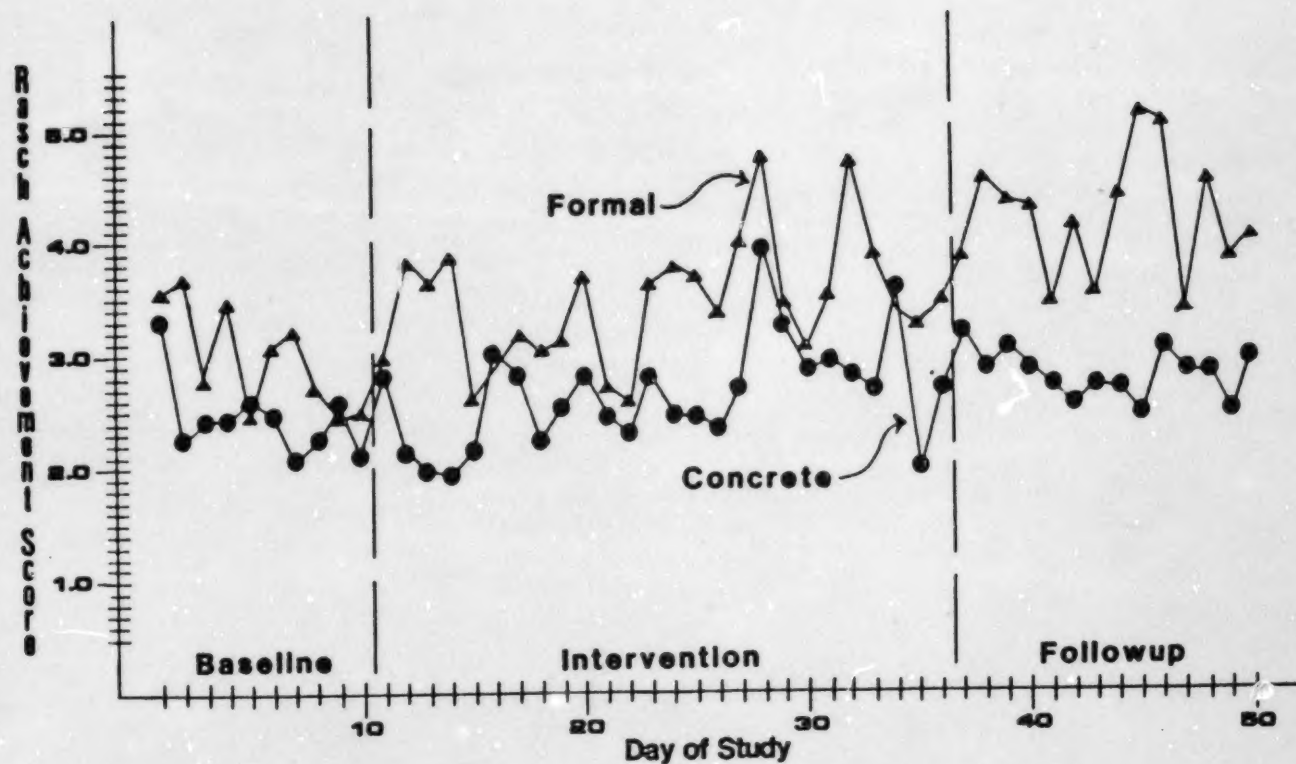


FIGURE 1

Teacher 1
Daily Rasch Achievement Scores
Cognitive Tendency Groups

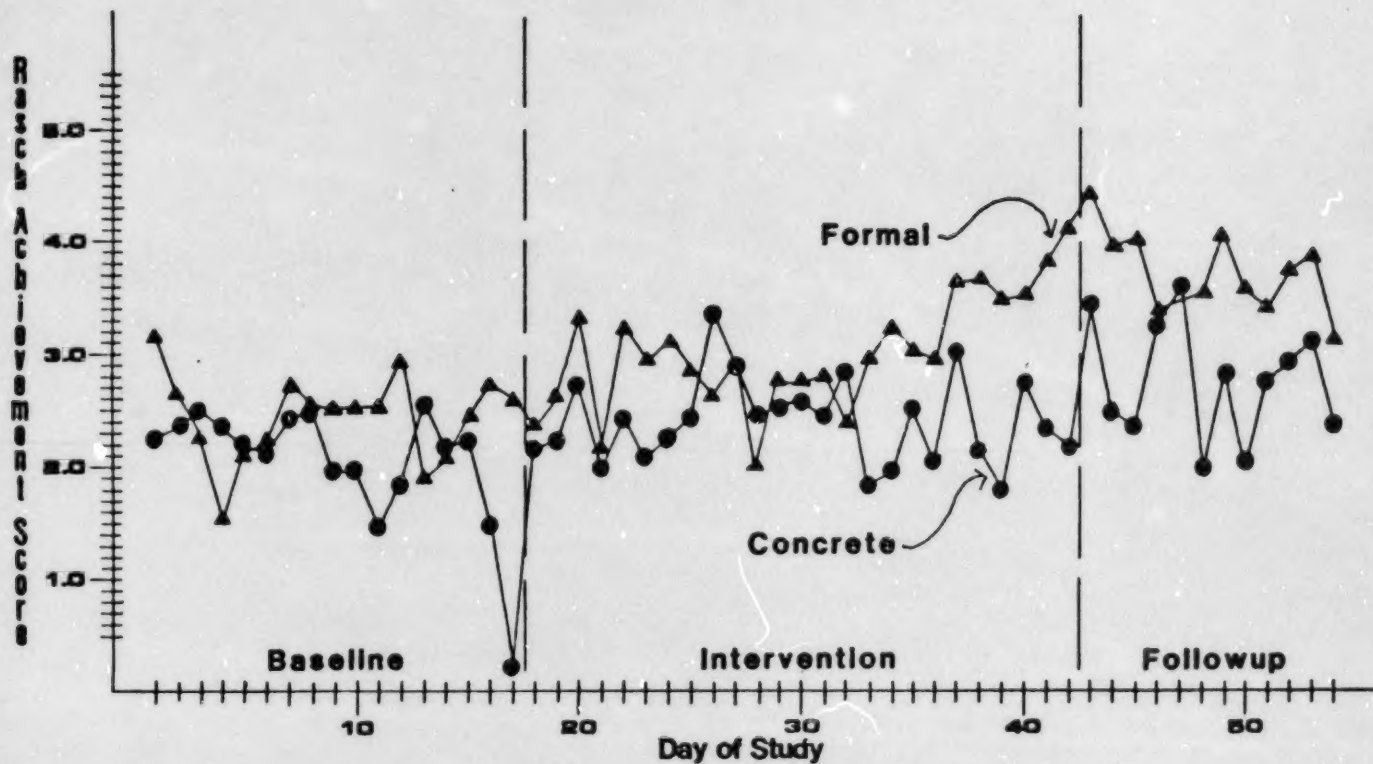


FIGURE 2

Teacher 2
Daily Rasch Achievement Scores
Cognitive Tendency Groups

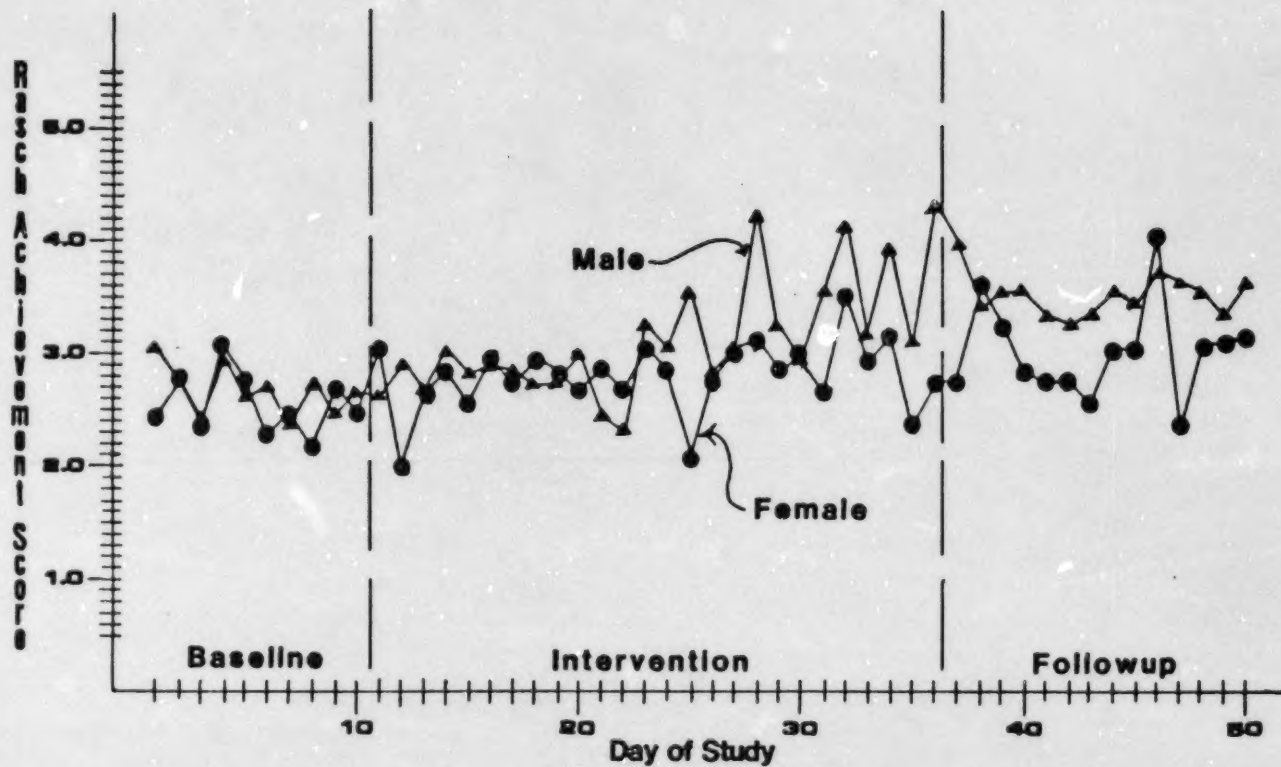


FIGURE 3

Teacher 1
Daily Rasch Achievement Scores
Gender Groups

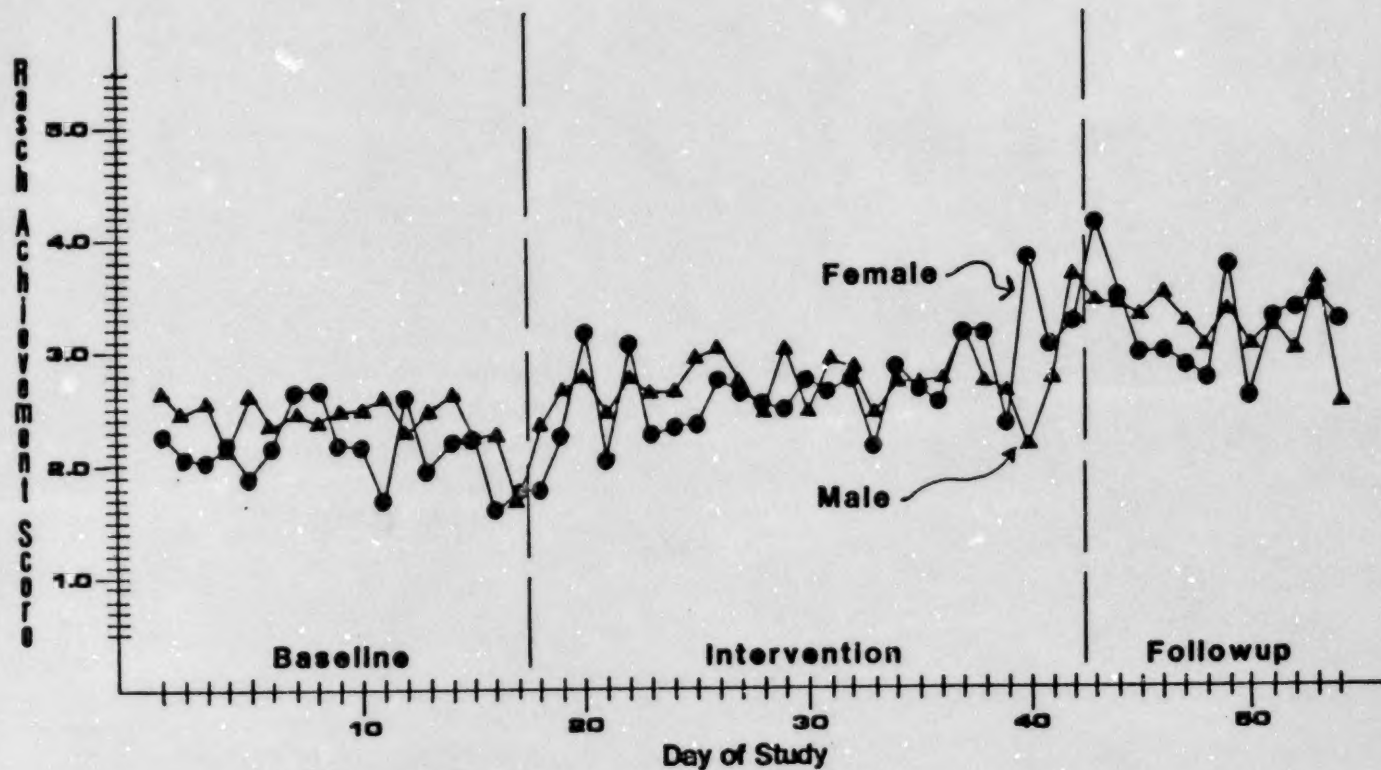


FIGURE 4

Teacher 2
Daily Rasch Achievement Scores
Gender Groups

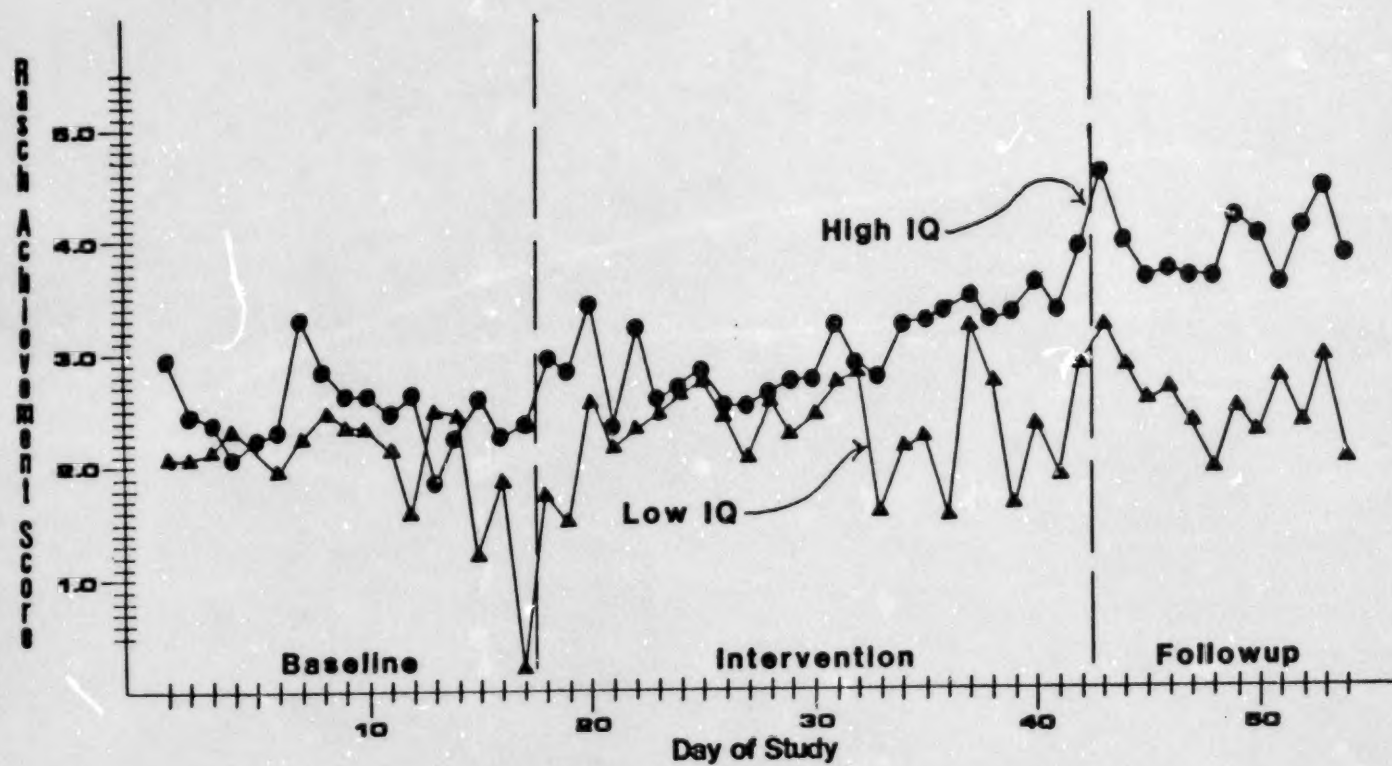


FIGURE 5

Teacher 2
Daily Rasch Achievement Scores
IQ Groups